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DIET AND EXERCISE INTERVENTION ADHERENCE AND HEALTH-RELATED OUTCOMES AMONG OLDER LONG-TERM BREAST, PROSTATE, AND COLORECTAL CANCER SURVIVORS

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ABSTRACT

Winger, Joseph G. M. S., Purdue University, December 2013. Diet and Exercise Intervention Adherence and Health-Related Outcomes among Long-Term Breast, Prostate, and Colorectal Cancer Survivors. Major Professor: Catherine D. Mosher.

Given the numerous benefits of a healthy diet and exercise for cancer survivors, there has been an increase in the number of lifestyle intervention trials for this population in recent years. However, the extent to which adherence to a diet and exercise intervention predicts health-related outcomes among cancer survivors is currently unknown. To address this question, data from the Reach out to ENhancE Wellness in Older Cancer Survivors (RENEW) diet and exercise intervention trial were analyzed. RENEW was a yearlong telephone and mailed print intervention for 641 older (≥65 years of age), overweight (body mass index: 25.0-39.9), long-term (≥5 years post-diagnosis) survivors of colorectal, breast, and prostate cancer. Participants were randomized to the diet and exercise intervention or a delayed-intervention control condition. The RENEW telephone counseling sessions were based on determinants of behavior derived from Social Cognitive Theory (SCT) (e.g., building social support, enhancing self-efficacy). These factors have been hypothesized to improve health behaviors, which in turn should improve health outcomes. Thus, drawing on SCT and prior diet and exercise research with cancer survivors, I hypothesized that telephone counseling session attendance would

be indirectly related to health-related outcomes (i.e., physical function, basic and advanced lower extremity function, mental health, and body mass index) through intervention-period strength and endurance exercise and dietary behavior (i.e., fruit and vegetable intake, saturated fat intake). The proposed model showed good fit to the data; however, not all of the hypothesized relationships were supported. Specifically, increased telephone counseling session attendance was related to engagement in all of the health behaviors over the intervention period. In turn, (a) increased endurance exercise was related to improvement in all of the health-related outcomes with the exception of mental health; (b) increased strength exercise was solely related to improved mental health; (c) increased fruit and vegetable intake was only related to improved basic lower extremity function; and (d) saturated fat intake was not related to any of the health-related outcomes. Taken together, these findings suggest that SCT determinants of behavior and the importance of session attendance should continue to be emphasized in diet and exercise interventions. Continued exploration of the relationship between adherence to a diet and exercise intervention and health-related outcomes will inform the development of more cost-effective and efficacious interventions for cancer and other medical populations.

CHAPTER 1. INTRODUCTION

1.1 Introduction

Numerous studies have shown the benefits of a healthy diet and exercise for cancer survivors (Bertram et al., 2011; Blanchard, Stein, & Courneya, 2010; Irwin, Alvarez-Reeves, et al., 2009; McCullough et al., 2011). To my knowledge, however, no studies have examined the relationship between adherence to a diet and exercise intervention and health-related outcomes among cancer survivors. Exploration of this relationship will inform the development of more cost-effective and efficacious interventions. This study was a secondary data analysis of the Reach out to ENhancE Wellness in Older Cancer Survivors (RENEW) randomized controlled trial (RCT). RENEW was a home-based diet and exercise intervention for older ($\geq$ 65 years of age), overweight (body mass index [BMI]: 25.0-39.9), long-term ($\geq$ 5 years post-diagnosis) survivors of colorectal, breast, and prostate cancer (Morey et al., 2009). The purpose of the present analyses was to examine the relationship between adherence to the RENEW intervention and health-related outcomes, including physical function, basic and advanced lower extremity function, mental health, and BMI. I hypothesized that greater telephone counseling session attendance would be related to better health-related outcomes (i.e., improved physical function, basic and advanced lower extremity function, and mental health as well as lower BMI) following the intervention, and that exercise (i.e., greater strength and endurance exercise) and dietary behavior (i.e., increased fruit and vegetable [F&V] intake, decreased saturated fat intake) over the intervention period would mediate this relationship. Findings will inform the design and adherence analysis of future diet and exercise interventions for cancer and other medical populations.

First, I will provide information on cancer survivors' increased health risk, health-related quality of life (HRQOL), and unhealthy lifestyle behaviors. Then, I will present the health benefits of a healthy diet and exercise. Next, I will discuss the findings from diet and exercise intervention trials with cancer populations. I will then discuss the measurement of adherence to diet and exercise interventions as well as the relationship between intervention adherence and health-related outcomes among older adults. Finally, I will present my hypotheses and methods and describe the findings and their implications.

1.2 Health Risk, HRQOL, and Unhealthy Lifestyle Behaviors

In the United States, there are approximately 12 million cancer survivors (Cancer Facts & Figures, 2012). The term *cancer survivor* refers to an individual from the time of diagnosis through the remainder of his or her life (Estimated US Prevalence Counts, 2011). The number of cancer survivors is rapidly increasing due to advances in cancer prevention, early-stage detection, and treatment (Gapstur & Thun, 2010; Kohler et al., 2011). Compared to non-cancer controls, cancer survivors are at an increased risk for secondary cancers and comorbidities such as cardiovascular disease, diabetes, and osteoporosis (Aziz, 2007; Brown, Brauner, & Minnotte, 1993; Demark-Wahnefried & Jones, 2008; Ganz, 2009; Travis, 2002; Yabroff, Lawrence, Clauser, Davis, & Brown, 2004). In a population-based study of 15,626 cancer cases, 68.7% of cancer survivors reported comorbid conditions (Ogle, Swanson, Woods, & Azzouz, 2000). Additionally, older ($\geq$65 years of age) cancer survivors may experience accelerated functional decline related to secondary cancers and comorbidities (Deimling, Sterns, Bowman, & Kahana, 2007).

Other studies have examined the impact of cancer and its treatment on HRQOL (Baker, Haffer, & Denniston, 2003; Yabroff et al., 2004). HRQOL is defined as an individual's functional status, physical and mental well-being, and overall evaluation of health (Ferrell, Dow, & Grant, 1995; Ware & Sherbourne, 1992). A national study of 22,747 cancer survivors receiving Medicare found that compared to age-matched non-cancer controls, cancer survivors scored significantly lower on all dimensions of HRQOL (Baker et al., 2003). These findings are congruent with those of other studies that showed poorer functional status, physical and mental well-being, and overall evaluation of health among older cancer survivors relative to age-matched non-cancer controls (Cepeda & Gammack, 2006; Cheng & Lee, 2011; Chirikos, Russell-Jacobs, & Jacobsen, 2002; Irwin, Alvarez-Reeves, et al., 2009; Retornaz et al., 2007).

Among cancer survivors, unhealthy lifestyle behaviors such as a poor diet, physical inactivity, excessive alcohol use, and smoking have been linked to increased risk of chronic diseases and lower HRQOL (Barrera & Demark-Wahnefried, 2009; Blanchard et al., 2010; Chan, Gann, & Giovannucci, 2005; McCullough et al., 2011; Sonn, Aronson, & Litwin, 2005). Unfortunately, many cancer survivors are not meeting national exercise and dietary guidelines, as their health habits are similar to those of the general population (Bellizzi, Rowland, Jeffery, & McNeel, 2005; Blanchard, Courneya, & Stein, 2008; Blanchard et al., 2004; Coups & Ostroff, 2005). Few studies have specifically examined the health habits of older adult cancer survivors (Rao & Demark-Wahnefried, 2006). One study found that among 688 older breast and prostate cancer survivors, 20.4% reported eating five or more daily servings of F&Vs, 61.0% reported diets with less than 30% of energy from fat, and 44.6% reported weekly vigorous exercise (Demark-Wahnefried et al., 2004). A population-based study of 9,105 cancer survivors (mean age = 67.18, *SD* = 11.23) found that depending on cancer type (i.e., breast, prostate, colorectal, bladder, uterine, or skin melanoma), 14.8% to 19.1% met national dietary recommendations, 29.6% to 47.3% met physical activity recommendations, and 82.6% to 91.6% did not smoke; however, only 5.0% met all three recommendations (Blanchard et al., 2008). Furthermore, an age-stratified, population-based study found minimal differences between cancer survivors and non-cancer controls concerning the prevalence of behavioral risk factors for disease (i.e., smoking, physical inactivity, unhealthy dietary habits, being overweight, risky alcohol use, sun protection behaviors), with the exception of high smoking rates among cervical and uterine cancer survivors (Coups & Ostroff, 2005).

1.3 Health Benefits of Exercise and a Healthy Diet

According to the American Cancer Society (ACS) guidelines, adult cancer survivors should: (a) engage in at least 150 minutes of moderate-intensity (or 75 minutes of vigorous-intensity) physical activity each week; (b) eat at least seven (for women) or nine (for men) servings of F&Vs each day; and (c) limit high calorie foods and drinks (Kushi et al., 2012). Adherence to ACS guidelines is associated with lower risk of death from cancer, cardiovascular disease, and all other causes (McCullough et al., 2011).

Numerous exercise RCTs have shown that regular exercise can improve HRQOL, BMI, disease risk, and survival among cancer survivors (Bertram et al., 2011; Blanchard et al., 2010; Irwin, Alvarez-Reeves, et al., 2009; McCullough et al., 2011). In contrast, studies examining the relationships between a healthy diet (i.e., high in F&Vs and low in saturated fat) and HRQOL, disease risk, and survival among cancer survivors have yielded mixed results (Demark-Wahnefried et al., 2004; Pierce et al., 2007). For example, a few cross-sectional studies of survivors of colorectal, breast, and prostate cancer have found a positive relationship between a healthy diet and HRQOL (Demark-Wahnefried et al., 2004; Wayne et al., 2006) with some evidence suggesting that a healthy diet is associated with fewer biomarkers for breast cancer (George et al., 2010). Conversely, a cross-sectional study of colorectal, breast, and prostate cancer survivors found no relationship between diet quality and HRQOL (Blanchard et al., 2004). Concerning the impact of a healthy diet on cancer recurrence and survival among breast cancer survivors, an RCT with 1,537 participants found no difference between the intervention group and attention control group at a 7-year follow-up (Pierce et al., 2007).

Thus, more research is needed to better understand the relationship between diet quality and health-related outcomes among cancer survivors.

1.4 Diet and Exercise Intervention Trials with Cancer Populations

In recent years, a number of diet and exercise intervention trials have been conducted with cancer survivors (Bloom, Stewart, D'Onofrio, Luce, & Banks, 2008; Demark-Wahnefried et al., 2007; Demark-Wahnefried et al., 2006; von Gruenigen et al., 2008). Exercise RCTs have demonstrated that exercise interventions can be safely implemented with cancer survivors (Pekmezi & Demark-Wahnefried, 2011). For example, breast cancer survivors can engage in regular strength training without increased risk of lymphedema (Ahmed, Thomas, Yee, & Schmitz, 2006; Courneya et al., 2007; Schmitz et al., 2010).

Both strength and endurance exercise have been found to yield health benefits for cancer survivors (Ligibel et al., 2008; Schmitz, Ahmed, Hannan, & Yee, 2005; Vallance, Courneya, Plotnikoff, Yasui, & Mackey, 2007). Exercise RCTs with cancer survivors have shown that strength training can increase the number of minutes of strength exercise per week (Ligibel et al., 2008) as well as improve physical function (LaStayo, Marcus, Dibble, Smith, & Beck, 2011), lower extremity function (Yuen & Sword, 2007), mental health (Milne, Wallman, Gordon, & Courneya, 2008), and lean body mass (Courneya et al., 2007; Schmitz et al., 2005). Similarly, RCTs with cancer survivors have demonstrated that endurance training can increase the number of minutes of endurance exercise per week (Vallance et al., 2007) as well as improve physical function (Fillion et al., 2008; Yuen & Sword, 2007), lower extremity function (Basen-Engquist et al., 2006; Kaltsatou, Mameletzi, & Douka, 2011; LaStayo et al., 2011), mental health (Courneya, Friedenreich, et al., 2003; Courneya, Mackey, et al., 2003; Daley et al., 2007; Rogers et al., 2009), and lean body mass (Courneya et al., 2007; Irwin, Alvarez-Reeves, et al., 2009). Additionally, in two recent meta-analyses, exercise interventions have been found to improve all aspects of HRQOL among cancer survivors (Ferrer, Huedo-Medina, Johnson, Ryan, & Pescatello, 2011; Fong et al., 2012). These findings were most pronounced in studies involving intense endurance exercise for breast cancer survivors and among methodologically rigorous RCTs.

A few of these intervention trials also measured biomarkers that may mediate the relationship between exercise and health benefits (Irwin, Varma, et al., 2009; Ligibel et al., 2009). For example, one endurance exercise RCT found decreases in growth factors (i.e., IGFBP-3, IGF-1) and insulin levels in the intervention arm relative to the usual care control arm (Irwin, Varma, et al., 2009). Similar results were found in a strength and endurance exercise RCT for breast cancer survivors, which resulted in lower insulin levels among intervention participants relative to control participants (Ligibel et al., 2009).

In RCTs with cancer survivors, dietary interventions have been found to improve F&V intake (Cartmel, Bowen, Ross, Johnson, & Mayne, 2005; Demark-Wahnefried, Polascik, et al., 2008; Heimendinger et al., 2005), reduce fat intake (Parry, Milne, Yadegarfar, & Rainsbury, 2011; Parsons et al., 2008), and lower BMI (Chlebowski et al., 2006). However, the majority of dietary interventions have been conducted solely among breast cancer survivors (Djuric et al., 2002; Hebert et al., 2001). These studies have shown that interventions focused on fat reduction have lowered BMI and reduced the percentage of energy from fat (Kristal, Shattuck, Bowen, Sponzo, & Nixon, 1997; Rose, Connolly, Chlebowski, Buzzard, & Wynder, 1993). Similarly, interventions focused on caloric restriction have lowered BMI (de Waard, Ramlau, Mulders, de Vries, & van Waveren, 1993; Djuric et al., 2002; Loprinzi et al., 1996). Finally, interventions targeting both F&V intake and fat reduction have improved overall diet quality (Nordevang, Callmer, Marmur, & Holm, 1992; Pierce et al., 2004) and reduced BMI (Hebert et al., 2001). However, there is mixed evidence concerning the impact of a healthy diet on cancer-related biomarkers and cancer recurrence (Aronson et al., 2010; Chlebowski et al., 2006; Pierce et al., 2007).

Combined diet and exercise RCTs for cancer survivors have shown similar findings relative to those focusing exclusively on diet or exercise. Results suggest that a combined diet and exercise invention can improve diet quality (Campbell et al., 2009; Demark-Wahnefried et al., 2006), BMI (Demark-Wahnefried, Case, et al., 2008; Demark-Wahnefried et al., 2007), and physical activity (Bloom et al., 2008; von Gruenigen et al., 2008). Only two diet and exercise interventions for cancer survivors have examined health-related biomarkers (Demark-Wahnefried, Case, et al., 2008; Demark-Wahnefried et al., 2007). One study found no difference between the intervention arm and an attention control arm with regard to insulin, binding globulin, C-reactive protein, or interleukin-1B (Demark-Wahnefried, Case, et al., 2008). However, another study showed small, beneficial changes in plasma cholesterol, low- and high-density lipoprotein, and interleukin-6 in the intervention group relative to the attention control group (Demark-Wahnefried et al., 2007). It should be noted that this study was underpowered to detect significant changes in biomarkers.

1.5 RENEW Diet and Exercise Trial

Reach out to ENhancE Wellness in Older Cancer Survivors (RENEW) was an RCT designed to test a home-based diet and exercise intervention for older ($\geq$65 years of age), overweight (BMI: 25.0-39.9), long-term ($\geq$5 years post-diagnosis) survivors of colorectal, breast, and prostate cancer (Morey et al., 2009). When detected early colorectal, breast, and prostate cancer have cure rates of 90% or higher (Cancer Advances in Focus, 2010). Furthermore, cancer is an age-related disease with 61% of cancer survivors being over the age of 65 (Estimated US Prevalence Counts, 2011). Thus older, long-term survivors of colorectal, breast, and prostate cancer represent a large group that must face the interrelated challenges of cancer survivorship and aging (Rao & Demark-Wahnefried, 2006). Specifically, older cancer survivors tend to experience accelerated functional decline leading to reduced independence (Baker et al., 2003; Hewitt, Rowland, & Yancik, 2003; Nagi, 1991). Given the importance of maintaining independence (e.g., reduced need for skilled nursing facilities, improved HRQOL), the Centers for Medicare and Medicaid Services stated that the sole concern in aging research among at-risk older adult populations should be maintaining functional independence and mobility (Centers for Medicare & Medicaid Services, 2008).

The main objective of the RENEW trial was to decrease the functional decline associated with aging and cancer survivorship through a combination of tailored mailed print materials and telephone prompts and counseling regarding diet and exercise. Participants were randomized to a yearlong intervention or a delayed-intervention control group. The delayed-intervention control group completed the intervention 2 years post-baseline. The intervention was based on SCT and the Transtheoretical Model (TTM; Bandura, 1986; Prochaska & DiClemente, 1983). SCT posits that behavior is the product of *reciprocal determinism* between people and their environment. That is, people affect their environment and their environment, in turn affects them. Central to SCT is the concept of *self-efficacy*, or the belief in one's ability to enact a behavior that will bring about a desired outcome (Bandura, 1986). From a health promotion standpoint, SCT proposes five core determinants of behavior: (a) *knowledge* of health risks, (b) *perceived self-efficacy* that one can bring about the desired outcome, (c) *outcome expectations* about the benefits and costs of a behavior, (d) *health goals* that one sets as well as plans for accomplishing those goals, and (e) *perceived social and structural facilitators and impediments* to change (Bandura, 2004). Perceived social and structural facilitators and impediments to change include factors that may increase or decrease the likelihood of carrying out an action either from a social (e.g., work stress) or a structural (e.g., the price of a gym membership) standpoint.

SCT determinants of behavior were the focus of the RENEW trial's telephone counseling sessions. During these sessions, trained health counselors (i.e., contracted exercise physiologists) engaged participants by providing knowledge of health risks, assessing the participants' self-efficacy for health behavior change, discussing possible barriers to the desired behavior, setting health goals, and discussing progress since previous sessions. The health counselors also provided social support and reinforced goal achievement. Thus, a prediction derived from SCT theory is that greater telephone counseling session attendance should lead to increased exercise and improved dietary behaviors, which in turn should produce better health-related outcomes. Conversely, non-attendance may be indicative of other problems (e.g., stressful life events) that may be related to reduced exercise and poorer dietary behaviors and, thus, worse health outcomes.

The primary outcome of the RENEW trial was change in self-reported physical functioning from baseline to 1-year post-baseline (Morey et al., 2009). Among older adults, physical function is an especially important outcome because it facilitates performance of tasks that are essential for independent living (Kaplan, Strawbridge, Camacho, & Cohen, 1993). Furthermore, one's level of physical functioning is predictive of long-term health care use (Guralnik & Ostir, 2000; Winograd et al., 1997). Secondary outcomes included changes in HRQOL, BMI, and physical activity. In addition, dietary intake was assessed by averaging multiple, unannounced 24-hour dietary recalls at baseline and 1- and 2-year follow-ups. The results showed that, compared to the delayed-intervention control group, the intervention group's physical function scores declined at a slower rate (Morey et al., 2009). Moreover, the intervention group reported significant improvement in basic and advanced lower extremity function, physical activity, dietary behaviors, HRQOL, and BMI relative to the control group at 1-year post-baseline. During the intervention period for the delayed-intervention group, participants' physical function and lower extremity function declined at a slower rate compared to the previous year of observation (i.e., no intervention; Demark-Wahnefried et al., 2012). After completing the intervention, the delayed-intervention group reported improvement in dietary behaviors, physical activity, and BMI compared to baseline. Post-intervention HRQOL scores for the delayed-intervention group have not been published. Thus, the RENEW trial demonstrated that, compared to no intervention, a telephone and mailed print diet and exercise intervention can reduce functional decline in this vulnerable population.

1.6 Adherence to Diet and Exercise RCTs

An important aspect of interpreting findings from diet and exercise RCTs is assessing adherence to the intervention protocols. The traditional definition of adherence is derived from the medication literature and refers to "the extent to which patients follow instructions they are given for prescribed treatments" (Haynes, Taylor, & Sackett, 1978, p.2). In a meta-analysis of exercise RCTs for sedentary older adults, it was noted that exercise adherence has been inconsistently and poorly defined across studies (Hong, Hughes, & Prochaska, 2008). The most common measures of exercise adherence are session attendance, duration, intensity, and trial completion (e.g., Courneya et al., 2008). Diet intervention adherence has received less research attention; however, it is most commonly defined as treatment goal achievement (e.g., Schmid, Jeffery, Onstad, & Corrigan, 1991; Tinker et al., 2002).

Adherence can be viewed as both a dichotomous variable and a continuous variable (Pinto, Rabin, & Dunsiger, 2009). As a dichotomous variable, a person is considered adherent if he or she meets a predetermined cutpoint such as a national exercise guideline (e.g., Morey et al., 2002) or dietary goals (e.g., Schmid, Jeffery, Onstad, & Corrigan, 1991; Tinker et al., 2002). As a continuous variable, adherence can be operationalized as the amount of exercise completed during a certain period (e.g., Peddle et al., 2009) or the percentage of energy from fat (e.g., Tinker et al., 2002).

The majority of literature on adherence to diet and exercise RCTs has focused on demographic, medical, and psychosocial predictors of adherence. Reviews of exercise RCTs among older adults have identified a number of predictors of poor intervention adherence such as female gender, advanced age, lower socioeconomic status (SES), higher BMI, multiple comorbidities, and lower levels of social support (King, Rejeski, & Buchner, 1998; Rhodes et al., 1999). One study examined predictors of adherence to a home-based exercise RCT for breast cancer survivors (Pinto et al., 2009). The results were similar to those of a review of older adults' adherence to exercise RCTs (K. A. Martin & Sinden, 2001), suggesting that higher baseline levels of physical activity and self-efficacy are consistent predictors of better exercise intervention adherence.

To date, predictors of adherence to diet RCTs have not been systematically reviewed. However among adults, self-monitoring dietary intake and counseling session attendance are the two factors most frequently associated with increased adherence to diet interventions (defined as treatment goal achievement) (Boutelle & Kirschenbaum, 1998; Schmid, Jeffery, Onstad, & Corrigan, 1991; Tinker et al., 2002; Urban, White, Anderson, Curry, & Kristal, 1992). Poor diet intervention adherence among overweight adults is associated with poor health (Karlsson et al., 1994), prior attempts at weight loss (Jeffery et al., 2003), increased number of life stressors (Van Horn, Dolecek, Grandits, & Skweres, 1997), and psychiatric illness (Jeffery et al., 2003).

There are mixed findings concerning demographic predictors of diet intervention adherence (Jeffery et al., 2003; Schmid et al., 1991; Tinker et al., 2002).

1.7 Intervention Adherence and Health-Related Outcomes

To my knowledge, there are no published studies examining the relationship between adherence to a diet and exercise RCT and health-related outcomes among cancer survivors. However, Fielding et al. (2007) examined the relationship between adherence to a 12-month physical activity intervention and improvement in physical functioning among older adults with functional limitations. Trial participants were randomized into a physical activity group or a health education control group. Adherence was measured as a dichotomous variable based on whether participants reached the minimum threshold of 150 minutes of moderate physical activity per week at 6 and 12 months post-baseline. Among those assigned to the physical activity group, there were no significant differences in physical functioning between individuals classified as adherent and non-adherent at 6 months post-baseline. At 12 months post-baseline, however, those in the physical activity group who reported at least 150 minutes of moderate activity per week over the past 6 months displayed significant improvement in physical functioning when compared to those reporting less than 150 minutes of moderate activity per week. These findings suggest that there may be a positive relationship between adherence and health-related outcomes in older adults.

Two exercise RCTs with older adults have also supported a positive effect of adherence on health outcomes (C. K. Martin, Church, Thompson, Earnest, & Blair, 2009; van Gool et al., 2005). Among overweight, older adults with osteoarthritis in the knee, greater exercise adherence (defined as the percentage of exercise sessions attended) was associated with significant improvement in physical functioning and mental health, as well as reduced BMI and less pain (van Gool et al., 2005). In an exercise RCT with sedentary, older women, greater caloric expenditure per week was related to improvement in HRQOL (C. K. Martin et al., 2009). However, in an exercise and yoga intervention study with older adults, there was no significant relationship between adherence (defined as class attendance) and health-related outcomes (Flegal, Kishiyama, Zajdel, Haas, & Oken, 2007). More research examining the relationship between diet and exercise intervention adherence and health-related outcomes among older adults is needed due to the limited number of studies and mixed results.

CHAPTER 2. THE PRESENT STUDY

The purpose of the present study is to examine the relationship between adherence to the RENEW intervention and health-related outcomes. The relationship between adherence to a diet and exercise intervention and health-related outcomes among cancer survivors is currently unknown. Exploration of this relationship will inform the design and adherence analysis of future diet and exercise interventions for cancer and other medical populations. Drawing upon research on older adults' adherence to diet and exercise interventions (C. K. Martin et al., 2009; van Gool et al., 2005) and SCT (Bandura, 1986, 2004), I created a conceptual model of the relationship between adherence to the RENEW intervention and health-related outcomes (see Figure 1). I hypothesized that telephone counseling session attendance would be indirectly related to health-related outcomes because during these sessions participants were not actually engaging in the targeted exercise and dietary behaviors. Rather, as discussed previously, during the sessions participants received social support, gained knowledge of health risks, assessed possible barriers to the desired behavior, set health goals, and discussed progress since the previous session. According to SCT (Bandura, 1986, 2004), as participants engage in these determinants of behavior their health behaviors should improve, which in turn should improve their health-related outcomes. Pathways between exercise and dietary behaviors and health-related outcomes were hypothesized based on previous research. Specifically, exercise RCTs with cancer populations have shown that increased strength and endurance exercise improves health-related outcomes (i.e., increases physical function, basic and advanced lower extremity function, and mental health as well as reduces BMI; Courneya et al., 2009; Irwin, Alvarez-Reeves, et al., 2009; Midtgaard et al., 2005). Furthermore, cross-sectional studies with cancer survivors have found a relationship between improved diet quality (i.e., increased F&V intake and decreased saturated fat intake) and better health-related outcomes (i.e., increased physical function, basic and advanced lower extremity function, and mental health as well as reduced BMI; Demark-Wahnefried et al., 2004; Wayne et al., 2006). My proposed conceptual model includes four specific hypotheses.

2.1 Hypotheses

H1: During the intervention period, increased telephone counseling session attendance will be associated with increased minutes of strength exercise, which will in turn be associated with improved health-related outcomes post-intervention (i.e., increased physical function, basic and advanced lower extremity function, and mental health as well as decreased BMI).

H2: During the intervention period, increased telephone counseling session attendance will be associated with increased minutes of endurance exercise, which will in turn be associated with improved health-related outcomes post-intervention (i.e., increased physical function, basic and advanced lower extremity function, and mental health as well as decreased BMI).

H3: During the intervention period, increased telephone counseling session attendance will be associated with increased F&V intake, which will in turn be associated with improved health-related outcomes post-intervention (i.e., increased physical function, basic and advanced lower extremity function, and mental health as well as decreased BMI).

H4: During the intervention period, increased telephone counseling session attendance will be associated with decreased saturated fat intake, which will in turn be associated with improved health-related outcomes post-intervention (i.e., increased physical function, basic and advanced lower extremity function, and mental health as well as decreased BMI

CHAPTER 3. METHOD

This study was a secondary analysis of data from the RENEW trial. I examined the relationship between adherence to the RENEW intervention and health-related outcomes. The trial design and methods were previously published (Snyder et al., 2009). The Institutional Review Boards of the North Carolina Central Cancer Registry (NCCCR) and Duke University Health System approved the trial procedures. Furthermore, trial procedures complied with the Health Insurance Portability and Accountability Act (HIPAA).

3.1 Participants

Participants were either self-referred or identified from the Duke Cancer Registry and the NCCCR. Inclusion criteria included being an overweight (BMI = 25.0-39.9), older adult ($\geq$65 years of age) who was five or more years post-diagnosis of colorectal, breast, or prostate cancer with no evidence of malignancy in the past five years. Exclusion criteria included meeting national physical activity guidelines (i.e., at least 150 minutes of moderate to vigorous exercise per week) or using warfarin or dialysis (contraindications to a high F&V diet). Additional exclusion criteria included: (a) cognitive impairment, (b) hearing impairment, (c) lack of English fluency, (d) living in a skilled nursing facility, and (e) contraindications to unsupervised exercise (e.g., recent heart attack, chronic obstructive pulmonary disease, angina, congestive heart failure, or wheelchair or walker use).

After identifying possible participants and corresponding physician codes from the Duke Cancer Registry and the NCCCR, physicians were approached for written permission to contact patients about the trial. Following physician approval, a study invitation letter was sent to a pool of 20,015 potential participants. From this pool, 17,859 (89.2%) either refused participation or did not respond to the letter. Subsequently, 2,156 potential participants completed consent forms and a screening questionnaire to assess eligibility. After completing the screener, 753 participants (34.9%) were eligible for the study; however, 112 participants were deemed ineligible after the baseline survey was administered (either too active or not overweight). Overall, 641 participants were recruited and randomized to the intervention (n = 319) or delayed-intervention control (n = 322). Block randomization by cancer type, race, and sex was utilized. A good retention rate (87.1%) was observed with 558 survivors completing the 1-year follow-up. Attrition did not differ by group assignment (intervention vs. delayed-intervention control group) or demographic or medical factors (Demark-Wahnefried et al., 2012). In addition, most delayed-intervention participants (84.8%) completed the yearlong intervention (see participant flow in Figure 2).

3.2 Procedures

The RENEW trial design was published in detail (Snyder et al., 2009). To summarize, RENEW was a yearlong program of telephone counseling and a tailored mailed print diet and exercise intervention based on SCT and the TTM (Bandura, 1986; Prochaska & DiClemente, 1983). Participants were randomized to the intervention group or a delayed-intervention control group. A delayed-intervention control group was used because previous studies have suggested that an attention control group may be a barrier to recruitment (Madsen et al., 2002). Once enrolled in the intervention, participants received a package in the mail containing exercise bands (three different strengths), a poster demonstrating lower extremity exercises, a pedometer, tableware designed to reduce food portions, a T-Factor Fat Gram Counter booklet (W.W. Norton & Company, New York, NY) to monitor saturated fat intake, and a personalized self-monitoring log for recording daily F&V intake and exercise behavior. The intervention was delivered via 15 telephone counseling sessions as well as tailored workbooks, eight automated telephone prompts, and four quarterly progress reports.

The tailored workbooks, telephone prompts, and progress reports were based on the TTM. According to the TTM, people progress through different stages of change (i.e., *precontemplation*, *contemplation*, *preparation*, *action*, and *maintenance*) and tailoring interventions to the individual's stage of change should increase their engagement in the intervention (Prochaska & DiClemente, 1983). For example, if a participant was in the *preparation* stage, the tailored components would focus on the importance of developing a diet and exercise plan. Conversely, if a participant was in the *action* stage, tailored intervention components would encourage them to remain committed to their plan. The content of the workbooks was tailored to the participants' stage of change. The workbooks included graphical comparisons of participants' current diet and exercise behaviors to the following guidelines for cancer survivors (see Kushi et al., 2012): (a) strength exercise every other day for at least 15 minutes; (b) endurance exercise every day for at least 30 minutes; (c) average daily consumption of seven to nine servings of F&Vs; and (d) average daily consumption of less than 10% of total calories from saturated fat. Moreover, eight automated TTM-tailored telephone prompts provided additional reinforcement and encouraged participants to change health behaviors. A sample prompt is the following: "Hello, I'm Dr. Demark from Duke University Medical Center and I'm so happy that you're part of the RENEW study! We hope the materials and the counseling calls will motivate you to exercise more and eat healthier foods. Keep in mind – you don't need to achieve your exercise and diet goals overnight, but over time, as you work with your personal trainer, the work should really pay off! Good bye for now and welcome to RENEW" (Snyder et al., 2009, p.5). Finally, four quarterly progress reports were tailored to the participants' stage of change and reinforced health behaviors through detailed graphs regarding the participants' overall progress. These reports were two pages consisting of a tailored motivational greeting and a graph depicting the participants' changes in targeted behaviors over the course of the intervention. Concluding the report was a tailored motivational sign-off and a magnet depicting the RENEW logo for hanging the reports on the refrigerator as an environmental cue.

During the yearlong trial, each participant received 15 telephone calls from an exercise physiologist (i.e., health counselor) who received didactic training in the study protocol. The health counselors were assigned participants that they instructed throughout the trial. During the first three weeks, counseling sessions were held every week, followed by two bi-weekly sessions, and concluding with 10 monthly sessions (see Figure 3). The calls ranged from 15 to 30 minutes and focused on the SCT determinants of behavior such as building social support and enhancing self-efficacy. The health counselors collaborated with the participants to evaluate progress, set goals, overcome barriers to health behavior change, locate resources, and field general questions. Counseling sessions were standardized through the use of a computer-assisted guide featuring branching algorithms. For example, if a participant was not ready to change his or her F&V intake, during the F&V section the health counselor would say, "I know that the last time we talked you weren't quite ready to start eating more fruits and vegetables, but it's really important for you to start. This time we are going to talk more about setting some goals."

3.3 Measures

Measures were administered via telephone at baseline and 1- and 2-year follow-ups. Follow-up surveys included all measures except for demographics, medical information, and comorbidities which were only collected at baseline.

Additionally, measures of physical function and lower extremity function were administered on a quarterly basis during the intervention period (see Figure 3 for an overview of intervention elements and timing).

3.3.1 Demographics and Medical Information

3.3.1.1 Demographics

Participants reported their age, gender, race, and education.

3.3.1.2 Medical information

Participants answered yes or no questions about their cancer treatment history (i.e., surgery, chemotherapy, radiation, hormonal therapy, other therapy).

3.3.1.3 Comorbidities

Six common medical conditions were reported and summed at baseline, including cataracts, high blood pressure, arthritis, circulation difficulties in arms or legs, heart trouble, and osteoporosis. This measure has been used in a previous exercise RCT for at-risk older adults (Morey et al., 1999).

3.3.2 Adherence

3.3.2.1 Telephone Counseling Session Attendance

Participants were contacted via telephone by health counselors throughout the yearlong intervention period (see Figure 3). If a participant missed a call, their health counselor would make call back attempts until the time frame for the next phone session; once the next time frame began, if the participant still had not been reached, he or she would be coded as missing the call. Numerous diet and exercise RCTs have used session attendance as a measure of adherence (Fielding et al., 2007; Schmid et al., 1991; van Gool et al., 2006; van Gool et al., 2005). Attending the RENEW telephone counseling sessions facilitated the acquisition of skills and knowledge regarding the core components of the intervention (i.e., SCT determinants of behavior). Furthermore, the number of telephone sessions attended is a behavioral measure of adherence; therefore, this measure is free from reporting biases associated with self-report measures.

3.3.2.2 Exercise and Dietary Behavior

Data on exercise and dietary behaviors were collected during sessions 2-15 of the 15 telephone counseling sessions for a total of 14 time points (see Figure 3). While these measures are retrospective—and thus subject to reporting biases—participants were given a self-monitoring log for recording their exercise behavior and F&V intake as well as a T-Factor Fat Gram Counter booklet (W.W. Norton & Company, New York, NY) to help them track their saturated fat intake. Additionally, participants were instructed to record their behavior immediately after completing the activity.

3.3.2.3 Strength Exercise

Participants were asked to refer to their self-monitoring log and report their strength exercise since the last call in response to the following questions: "How many days per week did you do the strength exercises? How many minutes each day did you do the strength exercises?"

3.3.2.4 Endurance Exercise

Participants were asked to refer to their self-monitoring log and report their endurance exercise since the last call in response to the following questions: "How many days per week did you do the endurance exercises? How many minutes each day did you do the endurance exercises?"

3.3.2.5 F&V Intake

Participants were asked to report their average daily servings of F&Vs since the last call.

3.3.2.6 Saturated Fat Intake

Participants were asked to report the average number of saturated fat grams eaten per day since the last call.

3.3.3 Outcomes

3.3.3.1 Physical Function

Physical function was assessed using the 10-item physical function subscale of the Medical Outcomes Study Short- Form-36 (SF-36; Ware & Sherbourne, 1992). The physical function subscale of the SF-36 has been tested among older adults and has shown good concurrent and discriminant validity with three performance-based measures including the Single Limb Stance time ($r = 0.42$, $p < 0.01$), 3-meter gait speed ($r = 0.75$, $p < 0.01$), and the Timed Up and Go Test ($r = -0.70$, $p < 0.01$; Bohannon, 2006, 2008). Moreover, the physical function subscale of the SF-36 has shown good reliability (Cronbach's $\alpha > 0.90$) and sensitivity to change (Bohannon, 2006, 2008; Bohannon & DePasquale, 2010; Sherman, Reuben, & Sherman, 1998). Scores are summed and transformed onto a standardized scale from 0 to 100, with higher scores representing better physical functioning (Ware & Sherbourne, 1992).

3.3.3.2 <u>Basic and Advanced Lower Extremity Function</u>

The basic and advanced lower extremity subscales of the Late Life Function and Disability Index (LLFDI) were administered (Haley et al., 2002; Jette et al., 2002). Basic lower extremity function refers to activities that require stooping, standing, and walking, whereas advanced lower extremity function refers to activities that require a higher level of endurance and physical ability (e.g., hiking uphill or running half a mile; Haley et al., 2002). These subscales consist of 25 items (11 items for advanced lower extremity function and 14 items for basic lower extremity function) scored on a scale from 0 to 100, with higher scores indicating better functioning. The LLFDI lower extremity subscales have shown good concurrent validity with the well-validated Short Physical Performance Battery (SPPB; rs = 0.63 – 0.73, $p < 0.01$; Guralnik et al., 1994), which assesses 400-meter walking speed and overall function. SPPB scores are predictive of disability, assisted living, and mortality (Guralnik & Ostir, 2000; Guralnik et al., 1994). Furthermore, the LLFDI has shown good predictive validity concerning disability limitations and disability frequency (rs = 0.37 – 0.44, $p < 0.01$) as well as high test-retest reliability (intraclass correlation coefficients = 0.91 – 0.98; Haley et al., 2002; Sayers et al., 2004).

3.3.3.3 Mental Health

Mental health was assessed using the 14-item mental health summary measure of the SF-36 (Ware & Sherbourne, 1992). The mental health summary measure is an aggregate of four subscales including: (a) four items assessing vitality, (b) two items assessing social functioning, (c) three items assessing role limitations due to emotional problems, and (d) five items assessing general mental health (i.e., depression and anxiety). For each of the four subscales, scores are summed and transformed onto a standardized scale from 0 to 100, with higher scores representing better mental health (Brazier et al., 1992).

Among older adults, the mental health summary measure of the SF-36 has shown good internal consistency across all four subscales (Cronbach's $\alpha > 0.80$ and reliability coefficients > 0.75), with the exception of social functioning (Cronbach's $\alpha = 0.79$ and reliability coefficient = .74; Brazier et al., 1992; Walters, Munro, & Brazier, 2001). Furthermore, results of multi-trait multi-method matrix (MTMM) analyses suggested that the summary measure has good convergent and discriminant validity with the validated Nottingham Health Profile (Hunt, McKenna, McEwen, Williams, & Papp, 1981) in older adult samples (Brazier et al., 1992; Walters, Munro, & Brazier, 2001).

3.3.3.4 Body Mass Index

BMI (kg/m^2) was calculated based on self-reported height and weight at baseline and self-reported weight at 1- and 2-year follow-up. Self-reported height and weight has been shown to be highly correlated with measured height and weight (*r*s = 0.89-0.97, $p < 0.01$) among older adults (Kuczmarski, Kuczmarski, & Najjar, 2001). However, population-based studies have found that older men tend to overestimate their height by a few centimeters and weight by less than a kilogram, whereas older women tend to overestimate their height by a few centimeters and underestimate their weight by less than a kilogram (Kuczmarski et al., 2001; Stommel & Schoenborn, 2009).

3.4 Data Analysis Strategy

3.4.1 Variable Computation

Variable computation was conducted using SPSS version 19.0 (SPSS, Chicago, IL, USA). Telephone counseling session attendance and the exercise and dietary behavior variables were stored in 15 separate spreadsheet files—one file for each telephone counseling session. To begin, I merged all 15 files based on participant ID number. Next, I computed the adherence variable by summing the number of telephone counseling sessions attended. I then computed the exercise and dietary behavior variables which were recorded during sessions 2-15. The strength and endurance exercise variables were computed by: (a) multiplying the number of days exercised by the number of minutes exercised each day; (b) summing the products (i.e., days multiplied by minutes); and (c) dividing the summed products by the number of telephone counseling sessions attended. Similarly, the F&V and saturated fat intake variables were computed by: (a) summing the amounts reported; and (b) dividing the sum by the number of telephone counseling sessions attended. Finally, I adjusted the age variable for the delayed-intervention group by adding 1 year to each participant's age because this variable was collected at baseline and the delayed-intervention group received the intervention at 1-year post-baseline.

3.4.2 Preliminary Data Analysis Strategy

Following the variable computation, I calculated the baseline descriptive statistics. Next, I conducted preliminary data analyses to screen for violations of the assumptions of path analysis including assessment of outliers, variable normality, and the subject to parameter ratio. I also examined the extent of missing data. Then I computed zero-order correlations as well as Phi and Psi correlation matrices, which provide an initial test of my hypotheses. Because the intervention was delivered first to the intervention group and then 1 year later to the delayed-intervention group, I first ran the path analysis with each group separately to determine whether the two groups could be combined. Additionally, I split the combined dataset into three separate groups based on telephone counseling session attendance (i.e., low attendance = 1-5 sessions, medium attendance = 6-10 sessions, high attendance = 11-15 sessions). Then I performed a sensitivity analysis by running three separate path analyses for groups with low, medium, and high attendance in order to assess potential bias in the exercise and dietary behavior variables. Finally, covariates were chosen based on the literature and included age, gender, education, and number of comorbidities. All four of these covariates have been shown to be: (a) predictors of diet and exercise intervention adherence among older adults (Jeffery et al., 2003; King et al., 1998; Rhodes et al., 1999); (b) correlates of exercise and dietary behaviors among older cancer survivors (McCullough et al., 2011); and (c) correlates of health-related outcomes among older cancer survivors (Blanchard et al., 2008; Deimling et al., 2007).

3.4.3 Primary Analysis Strategy

I performed a measured-variable path analysis using the student version of LISREL 8.8 (Joreskog & Sorbom, 2008) to test whether telephone counseling session attendance was indirectly related to improved health-related outcomes (i.e., physical function, lower extremity function, mental health, and BMI) following the intervention through improved exercise (i.e., increased strength and endurance exercise) and dietary behavior (i.e., increased F&V intake, decreased saturated fat intake) over the intervention period. Path analysis was chosen rather than multiple regression because it produces more accurate parameter estimates (Kline, 2011). Accuracy of parameter estimates is enhanced due to the use of full information maximum likelihood data imputation for missing data and the potential to include multiple, covarying outcomes (Kline, 2011; Pui-Wa & Qiong, 2007). Model fit was assessed using the χ^2 statistic and the root mean square error of approximation (RMSEA) statistic (Steiger, 1990). A non-significant χ^2 statistic indicates that the hypothesized model is acceptable because there is no difference between the modeled and the observed patterns of relationships (Kline, 2011). Additionally, the RMSEA statistic is an adjusted estimate of absolute fit accounting for the parsimony of the model; thus, smaller values represent better fit with values below 0.06 indicative of good fit (Browne & Cudeck, 1992; Hu & Bentler, 1999).

CHAPTER 4. RESULTS

4.1 Preliminary Analyses

4.1.1 Descriptive Statistics

Participant characteristics are shown in Table 1. The majority of participants were Caucasian (88.8%), female (54.1%), and college-educated (61.6%). Participants were, on average, 73 years of age (*SD* = 5). Additionally, participants on average had two medical comorbidities (*SD* = 1) and were 9 years post-diagnosis (*SD* = 3). Participants received surgery (88.8%), radiation (45.7%), chemotherapy (26.1%), hormonal therapy (42.0%), and other therapies (14.7%). Overall, participants attended an average of 61.9% of the 15 telephone counseling sessions (mean = 9 sessions, *SD* = 5; see Table 2). During the telephone counseling sessions, participants reported a mean of 27 minutes per week of strength exercise (*SD* = 20), which is below the recommended guideline of 60 minutes per week (Kushi et al., 2012). Furthermore, participants reported engaging in an average of 124 minutes of endurance exercise per week (*SD* = 71) compared to the recommended 210 minutes per week. Concerning dietary behavior, participants reported eating an average of six daily servings of F&Vs (*SD* = 2), which is below the recommended seven to nine servings (Kushi et al., 2012), but better than typical intakes for older adult cancer survivors (Demark-Wahnefried et al., 2004). Finally, average saturated fat intake was 14 grams per day (*SD* = 6), which tended to be in the recommended range depending on the number of calories eaten per day with the target being less than 10% of total calories from saturated fat (Kushi et al., 2012).

Concerning health-related outcomes (see Table 3), participants on average scored similarly to older adults in the general population on the physical function subscale of the SF-36 (Ware, Snow, Kosinski, & Gandek, 2000). Furthermore, the average score on the basic lower extremity function subscale of the LLFDI (Haley et al., 2002) suggested that participants had only minor troubles with basic performance tasks (e.g., stepping on and off a bus). However, the average score on the advanced lower extremity function subscale of the LLFDI (Haley et al., 2002) was indicative of troubles with more advanced tasks (e.g., running to catch a bus). The average score on the mental health summary measure of the SF-36 was comparable to that of older adults in the general population (Ware et al., 2000). Finally, following the intervention, participants reported an average BMI that is considered overweight but not obese.

4.1.2 Assumptions of Path Analysis

To test for violations of the assumptions of path analysis, I screened the study variables for outliers (i.e., z-scores +/- 3). There were minimal outliers; therefore, I used a Winsorization transformation (see Table 4; Tukey, 1962). Second, I examined the normality of the study variables by assessing skewness and kurtosis (see Table 5). All of the variables were within the recommended normality guidelines for path analysis; the skewness indices were less than the absolute value of 2.0, and the kurtosis indices were less than the absolute value of 7.0 (Kline, 2011). Third, I calculated the subject to parameter ratio (641/14) and found it to be well above the minimum recommendations for path analysis (Kline, 2011). Fourth, as suggested by Schafer and Graham (2002), I examined the missing data and concluded that the data were missing at random (see Table 6 for missingness by variable). As mentioned previously, attrition did not differ by group assignment (intervention vs. delayed-intervention), demographic, or medical factors (Demark-Wahnefried et al., 2012). Therefore, full information maximum likelihood data imputation was used for the path analysis (Kline, 2011).

4.1.3 Correlations

I computed zero-order correlations between study variables, which provide an initial examination of relationships proposed in my hypotheses (see Table 7). There were small to moderate relationships between telephone counseling session attendance and the exercise and dietary behaviors (i.e., strength exercise, endurance exercise, F&V intake, and saturated fat intake; rs = 0.23, 0.19, 0.31, -0.12, $p < 0.01$, respectively), thus providing some preliminary support for my hypotheses.

Correlations between exercise and dietary behavior and health-related outcomes also provided some initial support for my hypotheses. In preliminary support of H1, H2, and H3, increased strength and endurance exercise as well as increased F&V intake were all related to improved physical functioning (rs = 0.12, 0.31, 0.19, $p < 0.01$, respectively).

However, contrary to H4, saturated fat intake was not significantly related to physical functioning ($r = 0.09$, $p > 0.05$). Additionally, as proposed in H2 and H3, there were small positive relationships between endurance exercise and basic lower extremity function as well as F&V intake and this outcome (rs = 0.26, 0.18, $p < 0.01$, respectively). Contrary to H1 and H4, other exercise and dietary variables were not significantly related to basic lower extremity function. As additional preliminary support for H2 and H3, increased endurance exercise and F&V intake were both related to better advanced lower extremity function (rs = 0.32, 0.17, $p < 0.01$, respectively). However, there was no significant relationship between strength exercise (H1) and advanced lower extremity function; moreover, contrary to H4, increased saturated fat intake was related to improvement in this outcome ($r = .11$, $p < 0.05$). Regarding mental health, none of the dietary and exercise variables predicted this outcome, with the exception of a small positive correlation between strength exercise and mental health as proposed in H1 ($r = 0.13$, $p < 0.01$). Finally, with regard to BMI, both endurance exercise and F&V intake showed small negative relationships with this outcome (rs = -0.22, -0.09, $p < 0.05$, respectively); thus, there was preliminary support for H2 and H3, but not for H1 or H4. Additionally, in order to account for missing data and the structural paths, I computed a Phi matrix for the estimated correlations among the exogenous variables and Psi matrices for the estimated correlations among the endogenous variables (see Tables 8, 9, and 10).

4.2 Primary Analysis

The hypothesized model showed good fit for both the intervention and the delayed-intervention group data, χ^2 (5, N = 319) = 7.12, p = 0.21, RMSEA = 0.04, and χ^2 (5, N = 322) = 7.85, p = 0.16, RMSEA = 0.04, respectively. Therefore, I combined the two datasets for the primary analysis. Conversely, the sensitivity analysis of the exercise and dietary behavior variables revealed some differences between the groups with high (i.e., 11-15 sessions), medium (i.e., 6-10 sessions), and low (i.e., 1-5 sessions) telephone counseling session attendance. Specifically, the model showed acceptable fit to high attendance data, χ^2 (5, N = 324) = 10.63, p = 0.06, RMSEA = 0.06, and good fit to medium and low attendance data, χ^2 (5, N = 176) = 5.50, p = 0.36, RMSEA = 0.02, and χ^2 (5, N = 92) = 4.61, p = 0.47, RMSEA = 0.00, respectively.

4.2.1 Hypothesized Model Testing

I tested the hypothesized model that telephone counseling session attendance would be indirectly related to health-related outcomes post-intervention (i.e., physical function, basic and advanced lower extremity function, mental health, BMI) through strength and endurance exercise and dietary behavior (i.e., F&V intake, saturated fat intake) over the intervention period (see Figure 1 for conceptual model and Appendix C for LISREL syntax). The covariates included gender, age, education, and number of comorbidities and were included in all of the structural pathways. The model showed good fit to the combined intervention and delayed-intervention data, χ^2 (5, N = 641) =

5.49, $p = 0.36$, RMSEA = 0.01, and supported some of the hypothesized pathways (see Figure 4 for tested model, and see Table 11 for gamma coefficients). Telephone counseling session attendance had a significant indirect relationship with all of the health-related outcomes through intervention period exercise and dietary behavior with the exception of saturated fat intake. Specifically, there were small positive relationships between telephone counseling session attendance and physical function ($\beta = 0.11$, $p < 0.05$), basic lower extremity function ($\beta = 0.10$, $p < 0.05$), advanced lower extremity function ($\beta = 0.09$, $p < 0.05$), and mental health ($\beta = 0.05$, $p < 0.05$), as well as a negative relationship with BMI ($\beta = -0.06$, $p < 0.05$). Overall, the model accounted for 18.0% of the variance in physical function, 17.0% of the variance in basic lower extremity function, 26.0% of the variance in advanced lower extremity function, 4.0% of the variance in mental health, and 8.0% of the variance in BMI (see Figure 4).

4.2.1.1 Study Hypothesis 1

The model provided some support for H1 (see Figure 5). During the intervention period, increased telephone counseling session attendance was related to increased strength exercise ($\beta = 0.26$, $p < 0.05$), which in turn was related to better mental health ($\beta = 0.14$, $p < 0.05$). However, none of the other paths between strength exercise and health-related outcomes were significant.

4.2.1.2 Study Hypothesis 2

There was some support for H2 (see Figure 6). Increased telephone counseling session attendance was related to increased endurance exercise ($\beta = 0.26$, $p < 0.05$), which in turn was related to improved physical function ($\beta = 0.24$, $p < 0.05$), basic lower extremity function ($\beta = 0.18$, $p < 0.05$), and advanced lower extremity function ($\beta = 0.24$, $p < 0.05$) as well as reduced BMI ($\beta = -0.22$, $p < 0.05$; see Figure 6). Conversely, endurance exercise was not significantly related to mental health.

4.2.1.3 Study Hypothesis 3

There was also mixed support for H3 (see Figure 7). Increased telephone counseling session attendance was related to increased F&V intake ($\beta = 0.39$, $p < 0.05$), which in turn was related to improved basic lower extremity function ($\beta = 0.12$, $p < 0.05$). However, F&V intake was not significantly related to other health-related outcomes.

4.2.1.4 Study Hypothesis 4

Finally, the model partially supported H4 (see Figure 8). Increased telephone counseling session attendance was related to decreased saturated fat intake ($\beta = -0.11$, $p < 0.05$). However, saturated fat intake was not significantly related to any of the health-related outcomes (all *p*s > 0.05).

4.3 Conclusions from Primary Analyses

Overall, the tested model fit the data well and provided mixed support for the hypothesized pathways. Telephone counseling session attendance was related to engagement in all of the exercise and dietary behaviors during the intervention period. However, mixed associations were found between exercise and dietary behaviors and health-related outcomes. When controlling for covariates and the other structural paths: (a) strength exercise was the only health behavior that was significantly related to mental health; (b) endurance exercise was significantly related to all outcomes with the exception of mental health; (c) F&V intake was only related to basic lower extremity function; and (d) saturated fat intake was not significantly related to any of the outcomes.

CHAPTER 5. DISCUSSION

The purpose of this study was to examine the relationship between adherence to the RENEW intervention and health-related outcomes. To my knowledge, this study is the first to explore the relationship between adherence to a diet and exercise intervention and health-related outcomes among cancer survivors. I hypothesized that exercise and dietary behavior over the intervention period would explain the relationship between telephone counseling session attendance and health-related outcomes (see conceptual model in Figure 1). My hypotheses were informed by SCT (Bandura, 1986, 2004) as well as findings from diet and exercise RCTs (Demark-Wahnefried et al., 2007; Vallance et al., 2007) and cross-sectional studies with cancer survivors (Demark-Wahnefried et al., 2004; Wayne et al., 2006). Overall, mixed support was obtained for my hypotheses. Increased telephone counseling session attendance was related to engagement in all health behaviors over the intervention period. Moreover, increases in some health behaviors (i.e., strength and endurance exercise and F&V intake) over the intervention period accounted for the relationship between increased telephone session attendance and certain health benefits.

Endurance exercise was positively related to physical function and basic and advanced lower extremity function and negatively related to BMI. These results are consistent with previous findings from exercise RCTs with cancer survivors (Basen-Engquist et al., 2006; Fillion et al., 2008; Irwin, Alvarez-Reeves, et al., 2009; Kaltsatou et al., 2011). However, contrary to previous findings (Daley et al., 2007; Rogers et al., 2009), endurance exercise was not related to mental health. One potential explanation for this finding is that participants were not generally reporting poor mental health at baseline. Thus, there was a restriction of the variable's range, which reduced statistical power for detecting a significant relationship. Taken together, findings suggest that increased endurance exercise partially accounts for the relationships between increased telephone counseling session attendance and improved physical health outcomes (i.e., better physical function and basic and advanced lower extremity function as well as decreased BMI).

Increased strength exercise was related to improved mental health, as found in prior research with cancer survivors (Milne et al., 2008). However, in this study, strength exercise was unrelated to physical function, basic or advanced lower extremity function, and BMI. These findings were inconsistent with results from strength exercise RCTs for cancer survivors that have shown improvement in all of these outcomes, with the exception of BMI (LaStayo et al., 2011; Schmitz et al., 2005; Yuen & Sword, 2007). Given that participants were also engaging in endurance exercise, which improves physical function (Fillion et al., 2008; Yuen & Sword, 2007), strength exercise may not have contributed to this outcome above and beyond the effect of endurance exercise. That is, endurance exercise explained unique variance in physical function, whereas strength exercise did not. Also, measurement issues may have contributed to the lack of relationship between strength exercise and basic and advanced lower extremity function.

In previous studies (Basen-Engquist et al., 2006; LaStayo et al., 2011), basic and advanced lower extremity function were assessed using objective physical performance tests that measured walking distance (e.g., walking 50 feet as fast as possible) and timed sit-to-stand tests (e.g., sitting and standing as fast as comfortable). Thus, the null findings in the present study may be attributable to using less sensitive self-report measures. Furthermore, although there has been some empirical support for the notion that strength exercise increases lean body mass and decreases the percentage of body fat (Courneya et al., 2007; Schmitz et al., 2005), there has been limited support for the role of strength exercise in improving BMI (Bourke et al., 2011). One potential explanation for the mixed results is that BMI may not be a sensitive measure of clinically significant changes in body composition (Burkhauser & Cawley, 2008).

With regard to dietary behaviors over the intervention period, increased F&V intake was related to improved basic lower extremity function, but it was not related to physical function, advanced lower extremity function, mental health, or BMI. In addition, saturated fat intake was not related to any of the outcomes. Prior research has also yielded mixed evidence for relationships between dietary variables and health-related outcomes (Blanchard et al., 2004; Demark-Wahnefried et al., 2004; Wayne et al., 2006). Specifically, two cross-sectional studies with cancer survivors have found relationships between improved diet quality (i.e., increased F&V intake, decreased saturated fat intake) and improved physical function (Demark-Wahnefried et al., 2004) and mental health (Wayne et al., 2006), whereas another cross-sectional study found no significant relationship between F&V intake and mental or physical health in this population (Blanchard et al., 2004).

Given the conflicting findings, more research is needed in order to better understand if there is in fact a relationship between these variables.

The current findings have implications for theory, research, and clinical practice. The RENEW telephone counseling sessions were based on SCT (Bandura, 1986, 2004). During sessions participants set goals, monitored their progress, received social support, and discussed potential barriers to their desired behavior changes. Increased session attendance was related to improved strength exercise, endurance exercise, F&V intake, and saturated fat intake. Thus, SCT determinants of behavior may have improved exercise and dietary behavior over the intervention period. These findings suggest that SCT determinants of behavior should continue to be targeted in diet and exercise interventions.

The current findings also support and extend results of adherence analyses of RCTs with older adults (Fielding et al., 2007; C. K. Martin et al., 2009; van Gool et al., 2005). Two RCTs have examined the relationship between exercise session attendance and health-related outcomes (i.e., HRQOL, physical function) among older adults (Flegal et al., 2007; van Gool et al., 2005). These studies yielded mixed findings; however, in contrast to the present telephone intervention trial, participants exercised during the intervention sessions. Therefore, in these studies, one would hypothesize a direct relationship between session attendance and health-related outcomes.

While the majority of studies examining adherence to lifestyle interventions have focused on predictors of adherence (K. A. Martin & Sinden, 2001; Pinto et al., 2009), this study demonstrates the importance of examining the relationship between adherence and health outcomes. Understanding which health behaviors are most predictive of specific health outcomes will inform the design of future diet and exercise interventions. Future studies should consider investigating strategies designed to increase session attendance. Such strategies could include flexible telephone counseling session schedules (e.g., nights and weekends), increasing incentives for session attendance, or improving staff training and clinical skills, which may lead to more cost-effective and efficacious interventions.

The current study also has implications for clinical practice. First, these findings suggest that when addressing lifestyle changes, clinicians should repeatedly inform older adult cancer survivors of the importance of gaining health knowledge, setting health goals, monitoring progress, addressing barriers to health behavior change, and receiving social support. Given findings concerning relationships between exercise and F&V intake and health-related outcomes, the importance of regular engagement in these health behaviors should be emphasized. Moreover, these findings support previous studies indicating that older adults can improve their health behaviors, and the improvement can in turn lead to better physical function (Demark-Wahnefried et al., 2007; Demark-Wahnefried et al., 2006). Thus, clinicians may increase older adults' adherence to health behavior recommendations by explaining that these lifestyle changes may help one maintain independence for a longer period.

5.1 Limitations, Strengths, and Future Directions

Limitations of the present study should be noted. First, the tested model is only one potential explanation for the observed patterns of relationships, and, as with any multivariate analysis, alternative models and theories should be explored (Kline, 2011;

McDonald & Ho, 2002). Second, there were some limitations regarding the measurement of health behaviors and health-related outcomes. Results from the exercise and dietary variable sensitivity analysis revealed possible bias related to their computation. That is, the tested model fit the data better for those with low and medium session attendance than for those with high attendance. One potential explanation for these findings is that there may have been a threshold effect concerning the number of sessions attended, such that there were minimal gains in exercise and dietary behaviors after 11 sessions. Thus, the relationships between session attendance and health behaviors were attenuated for those with high attendance and the tested model fit the data better for those with low and medium attendance (i.e., less than 11 sessions). Furthermore, self-report measures are subject to other biases such as demand characteristics, recall bias, recency, and saliency. It is important to note, however, that participants were given a T-Factor Fat Gram Counter booklet (W.W. Norton & Company, New York, NY) to monitor saturated fat intake and a personalized self-monitoring log for recording daily F&V intake and exercise behavior to help increase the accuracy of their reports and minimize some of these biases. Future studies should include more objective measures of exercise (e.g., physical performance tests) and dietary intake (e.g., diet-related biomarkers). Moreover, some studies have suggested that it may be more important to examine clusters of health behaviors rather than isolated behaviors (Blanchard et al., 2004; Maunsell, Drolet, Brisson, Robert, & Deschênes, 2002). For example, future studies could explore differences in HRQOL between those who meet diet and exercise recommendations and those who meet only diet or exercise recommendations.

Additionally, some of the null findings may be attributable to imprecise measures and a restricted range in scores for certain assessments. Specifically, the null findings related to BMI may be due to a lack of sensitivity to changes in body composition. Future studies may benefit from using more technologically advanced and objective measures of body composition such as magnetic resonance imaging (MRI) or dual energy x-ray absorptiometry (DEXA; Burkhauser & Cawley, 2008). Also of note, the current study specifically targeted overweight cancer survivors and, thus, there was a restriction of range in BMI scores. Similarly, the null findings related to mental health may have been due to range restriction. In order to better examine the relationships between intervention adherence, BMI, and mental health, future studies would benefit from a more representative sample.

Finally, external validity of the findings may be threatened due to the homogeneity of the sample. Participants were predominately White, well-educated, and represented a small minority of those who received information about the study. Thus, findings may not replicate in the general population of older, long-term overweight cancer survivors. Future studies would benefit from a more diverse sample, especially given that previous research found race and socioeconomic status to be predictors of diet and exercise intervention adherence (King et al., 1998; Rhodes et al., 1999).

The current study also has a number of strengths that should be mentioned. RENEW was the first telephone and mailed print delivered lifestyle intervention for older adult cancer survivors. Moreover, the sample size was large and included participants from 21 US states as well as the United Kingdom and Canada with minimal attrition given the study population and the duration of the trial. In addition, the outcome measures were well-validated and reliable for use with older adults. Lastly, this study tested a theory- and research-based conceptual model using SEM, which allowed for the accuracy of parameter estimates to be enhanced through full information maximum likelihood data imputation for missing data (Kline, 2011; Pui-Wa & Qiong, 2007).

5.2 Conclusion

Older adult cancer survivors tend to experience accelerated functional decline that leads to reduced independence, and maintaining independence is the foremost concern in research with older adult populations at risk of disease (Centers for Medicare & Medicaid Services, 2008; Baker et al., 2003; Hewitt et al., 2003; Nagi, 1991). The RENEW intervention was designed to target functional decline in this vulnerable population. In contrast to prior research which has examined the relationship between exercise intervention adherence and health-related outcomes among older adults (Flegal et al., 2007; van Gool et al., 2005), the current study explored this relationship in a diet and exercise intervention for older adult cancer survivors. The results showed that increases in some health behaviors (i.e., strength and endurance exercise and F&V intake) over the intervention period accounted for the relationship between increased telephone session attendance and certain health benefits. These findings support the importance of incorporating SCT determinants of health behavior change (Bandura, 1986, 2004) in both research and clinical settings. However, more research is needed to further examine the relationship between intervention adherence and health-related outcomes. Future intervention trials could implement a dose-response design testing the relationship between varying doses of the intervention (e.g., number of counseling sessions) and outcomes. This research would help determine the optimum dose of the intervention needed to significantly improve health-related outcomes.

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TABLES

TABLES

Table 1

Participant Characteristics at Baseline

Characteristics	No. (%) of Participants[a]
Age, mean (*SD*)	73.08 (5.05)
White race	569 (88.8)
Female sex	347 (54.1)
Some college education	395 (61.6)
No. of comorbidities, mean (*SD*)	2.01 (1.24)
Cancer type	
Breast	289 (45.1)
Prostate	261 (40.7)
Colorectal	91 (14.2)
Years since diagnosis, mean (*SD*)	8.58 (2.66)
Treatment type	
Surgery	569 (88.8)
Radiation	293 (45.7)
Chemotherapy	167 (26.1)
Hormonal therapy	269 (42.0)

Note. $N = 641$. [a]Unless otherwise indicated

Table 2

Means, Standard Deviations, and Ranges for Telephone Counseling Session Attendance and Exercise and Dietary Behaviors

	TEL	STR	END	FV	SAT
Mean	9.28	27.22	123.92	5.52	14.29
SD	4.56	19.75	70.57	1.79	5.79
Range	0-15	0-85	0-340	0-11	0-28
ns	641	577	572	567	522

Note. The variation in sample size is due to missingness. *SD* = standard deviation. TEL = number of telephone counseling sessions attended; STR = average minutes of strength exercise per week; END = average minutes of endurance exercise per week; FV = fruit and vegetable servings per day; SAT = saturated fat grams per day. Exercise variables were calculated by summing the number of minutes of exercise reported at each telephone counseling session and dividing the sum by the number of sessions attended. Dietary variables were calculated by summing the amounts reported at each telephone counseling session and dividing the sum by the number of sessions attended.

Table 3

Means, Standard Deviations, and Ranges for Health-Related Outcomes

	PF	BLE	ALE	MH	BMI
Mean	71.71	78.09	52.29	56.88	28.23
SD	23.08	15.47	17.11	6.34	3.42
Range	5-100	38-100	0-100	38-73	21-38

Note. *N* = 514. *SD* = standard deviation. PF = physical function subscale of the SF-36; BLE = basic lower extremity function subscale of the Late Life Function and Disability Index; ALE = advanced lower extremity function subscale of the Late Life Function and Disability Index; MH = mental health summary measure of the SF-36; BMI = body mass index. All variables were assessed following the intervention.

Table 4

Winsorization of Main Study Variable Outliers

	Variable value	
Variable	Original	Winsorized*
STR		
	90.00	85.00
	90.00	85.00
	90.00	85.00
FV		
	11.77	11.00
END		
	354.55	340.00
	360.00	340.00
	399.64	340.00
	401.15	340.00
	406.15	340.00
	410.00	340.00
MH		
	35.00	38.00
	35.00	38.00
	34.00	38.00
	34.00	38.00
BMI		
	40.00	38.00
	41.00	38.00
	44.00	38.00

Note. STR = average minutes of strength exercise per week; END = endurance exercise in average minutes per week; FV = fruit and vegetable servings per day; MH = mental health summary measure of the SF-36; BMI = body mass index post-intervention.
*Winsorizing variables involves changing their value to reflect a z-score of +/- 3.

Table 5

Skewness and Kurtosis of Study Variables

	Normality estimate	
Variable	Skewness	Kurtosis
TEL	-.72	-.63
STR	.43	-.29
END	.55	-.19
FV	-.17	.17
SAT	-.43	-.26
PF	-.88	-.21
BLE	-.05	-.93
ALE	-.20	.67
MH	-1.27	1.75
BMI	.73	.15
GEN	.18	-1.97
AGE	.37	-.63
EDU	-.48	-1.78
COM	.37	-.20

Note. *ns* = 641-514 due to missingness. TEL = telephone counseling session attendance; STR = strength exercise in average minutes per week; END = endurance exercise in average minutes per week; FV = fruit and vegetable servings per day; SAT = saturated fat grams per day; PF = physical function subscale of the SF-36; BLE = basic lower extremity function subscale of the Late Life Function and Disability Index; ALE = advanced lower extremity function subscale of the Late Life Function and Disability Index; MH = mental health summary measure of the SF-36; BMI = body mass index post-intervention; GEN = gender; EDU = education; COM = number of comorbidities.

Table 6

Missingness by Variable

	STR	END	FV	SAT	PF	BLE	ALE	MH	BMI
No. Missing	64	69	74	119	127	127	127	127	127
% of 641	10.0%	10.8%	11.5%	18.6%	19.8%	19.8%	19.8%	19.8%	19.8%

Note. Missingness calculated for outcomes post-intervention and health behaviors during the intervention period. STR = strength exercise in average minutes per week; END = endurance exercise in average minutes per week; FV = fruit and vegetable servings per day; SAT = saturated fat grams per day; PF = physical function subscale of the SF-36; BLE = basic lower extremity function subscale of the Late Life Function and Disability Index; ALE = advanced lower extremity function subscale of the Late Life Function and Disability Index; MH = mental health summary measure of the SF-36; BMI = body mass index post-intervention.

Table 7

Zero-Order Correlations for Main Study Variables

	TEL	STR	END	FV	SAT	PF	BLE	ALE	MH
TEL	---								
STR	.23**	---							
END	.19**	.26**	---						
FV	.31**	.27**	.37**	---					
SAT	-.12**	.01	.11*	.31**	---				
PF	.11*	.12**	.31**	.19**	.09	---			
BLE	.06	.06	.26**	.18**	.07	.76**	---		
ALE	.02	.06	.32**	.17**	.11*	.82**	.77**	---	
MH	.04	.13**	.07	.06	.04	.12**	.23**	.15**	---
BMI	-.09*	-.03	-.22**	-.09*	.01	-.28**	-.26**	-.23**	.05

Note. *ns* = 577-471 due to missingness. TEL = telephone counseling session attendance; STR = strength exercise in average minutes per week; END = endurance exercise in average minutes per week; FV = fruit and vegetable servings per day; SAT = saturated fat grams per day; PF = physical function subscale of the SF-36; BLE = basic lower extremity function subscale of the Late Life Function and Disability Index; ALE = advanced lower extremity function subscale of the Late Life Function and Disability Index; MH = mental health summary measure of the SF-36; BMI = body mass index post-intervention. $*p < 0.05$. $**p < 0.01$.

Table 8

Standardized Phi Correlation Matrix for Covariates

	GEN	AGE	EDU	COM
GEN	---			
AGE	.15*	---		
EDU	.17*	.01	---	
COM	-.20*	.09*	-.07	---

Note. *N* = 641. GEN = gender; EDU = education; COM = number of comorbidities. **p* < 0.05.

Table 9

Standardized Psi Correlation Matrix for Exercise and Dietary Behaviors

	STR	END	FV	SAT
STR	.92*			
END	.21*	.89*		
FV	.18*	.27*	.82*	
SAT	.05	.08*	.29*	.89*

Note. N = 641. STR = average minutes of strength exercise per week; END = average minutes of endurance exercise per week; FV = fruit and vegetable servings per day; SAT = saturated fat grams per day. *$p < 0.05$.

Table 10

Standardized Psi Correlation Matrix for Health-Related Outcomes

	PF	BLE	ALE	MH	BMI
PF	.82*				
BLE	.60*	.83*			
ALE	.62*	.56*	.74*		
MH	.06	.18*	.08*	.96*	
BMI	-.21*	-.21*	-.18*	.06	.92*

Note. N = 641. PF = physical function subscale of the SF-36; BLE = basic lower extremity function subscale of the Late Life Function and Disability Index; ALE = advanced lower extremity function subscale of the Late Life Function and Disability Index; MH = mental health summary measure of the SF-36; BMI = body mass index post-intervention. $^*p < 0.05$.

Table 11

Standardized Gamma Coefficients

	Endo									
Exo	TEL	STR	END	FV	SAT	PF	BLE	ALE	MH	BMI
GEN	-.09*	-.05	.14*	.13*	.27*	.09*	.15*	.24*	.04	.05
AGE	.03	.08*	-.09*	.06	.00	-.09*	-.14*	-.20*	-.05	-.15*
EDU	.07	.03	.02	.04	-.04	.00	-.02	.00	-.01	-.09*
COM	-.02	-.05	-.11*	-.07	-.09*	-.20*	-.19*	-.20*	-.08	.06

Note. $N = 641$. TEL = telephone counseling session attendance; STR = average minutes of strength exercise per week; END = average minutes of endurance exercise per week; FV = fruit and vegetable servings per day; SAT = saturated fat grams per day; PF = physical function subscale of the SF-36; BLE = basic lower extremity function subscale of the Late Life Function and Disability Index; ALE = advanced lower extremity function subscale of the Late Life Function and Disability Index; MH = mental health summary measure of the SF-36; BMI = body mass index post-intervention; GEN = gender; EDU = education; COM = number of comorbidities. $*p < 0.05$.

FIGURES

FIGURES

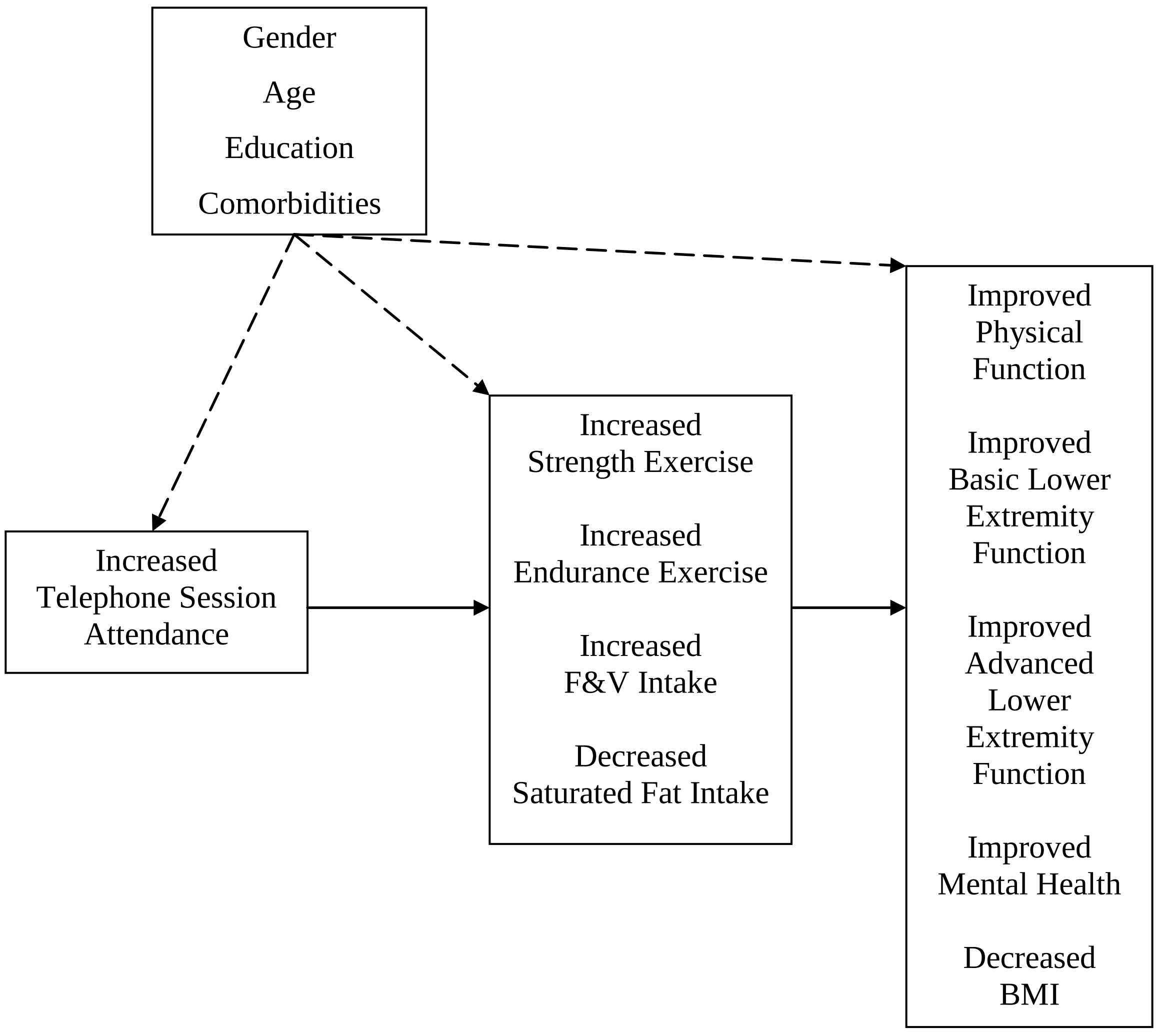

Figure 1. Proposed conceptual model. F&V = fruit and vegetable. BMI = body mass index.

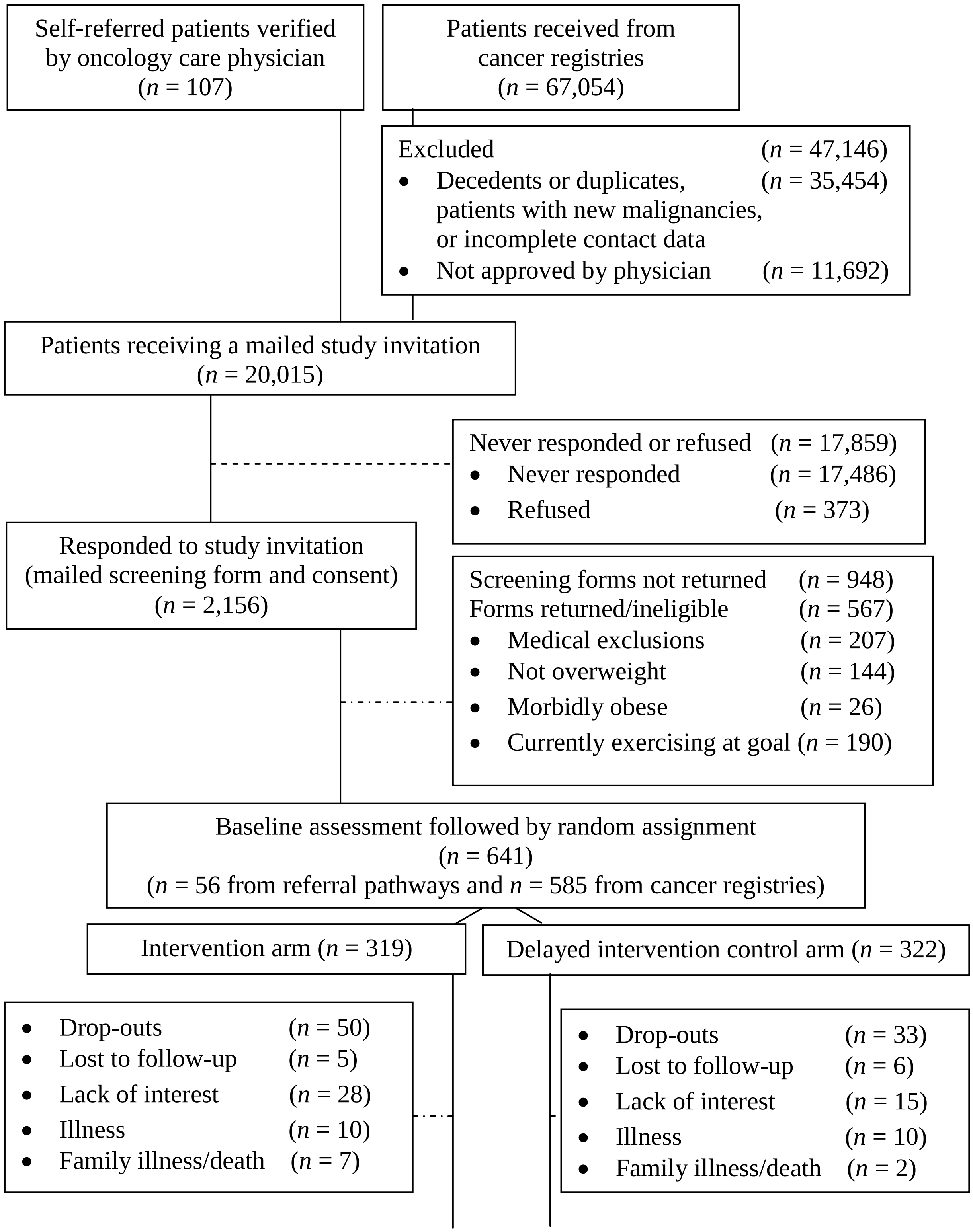

Figure 2 Continued.

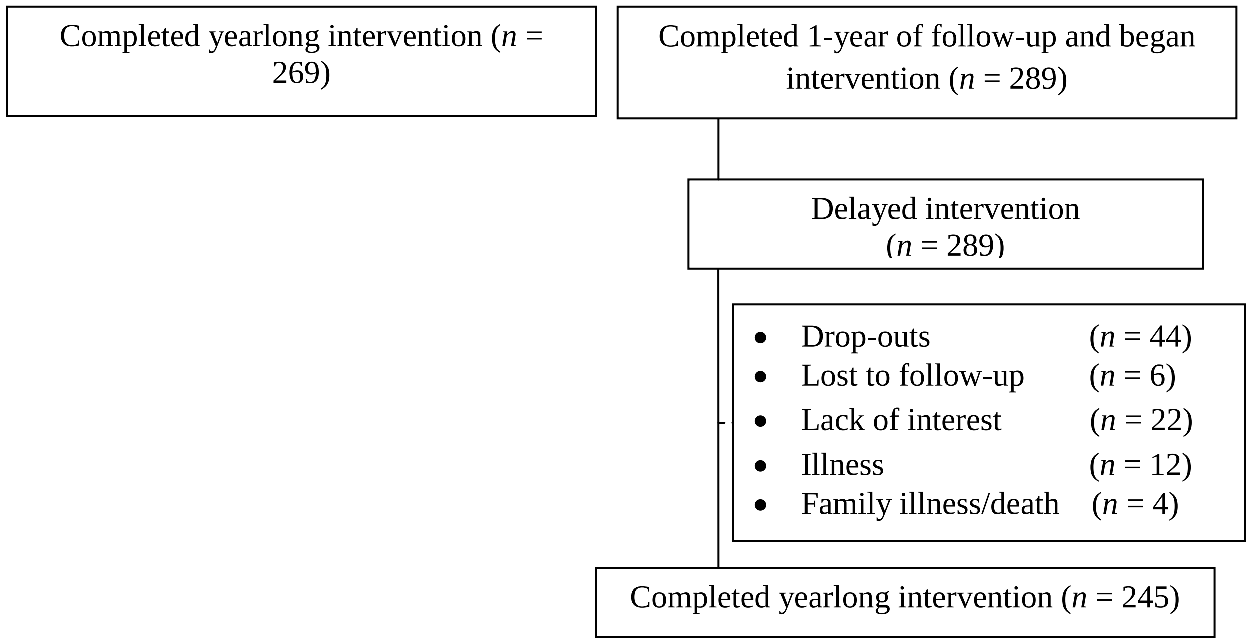

Figure 2. Intervention flow diagram. Adapted from Demark-Wahnefried, W., Morey, M. C., Sloane, R., Snyder, D. C., Miller, P. E., Hartman, T. J., & Cohen, H. J. (2012). Reach out to enhance wellness home-based diet-exercise intervention promotes reproducible and sustainable long-term improvements in health behaviors, body weight, and physical functioning in older, overweight/obese cancer survivors. *Journal of Clinical Oncology, 30*, 2354-2361. doi: 10.1200/JCO.2011.40.0895

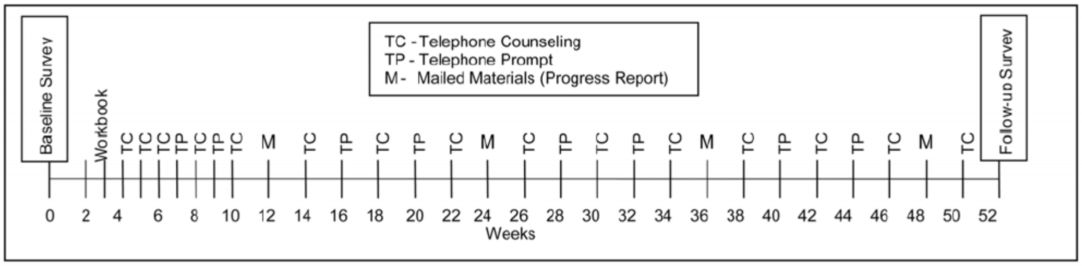

Figure 3. Intervention elements and their timing over 52-week intervention period. Adapted from Snyder, D. C., Morey, M. C., Sloane, R., Stull, V., Cohen, H. J., Peterson, B., . . . Demark-Wahnefried, W. (2009). Reach out to ENhancE Wellness in Older Cancer Survivors (RENEW): Design, methods and recruitment challenges of a home-based exercise and diet intervention to improve physical function among long-term survivors of breast, prostate, and colorectal cancer. *Psycho-Oncology*, *18(4)*, 429-439. doi: 10.1002/pon.1491

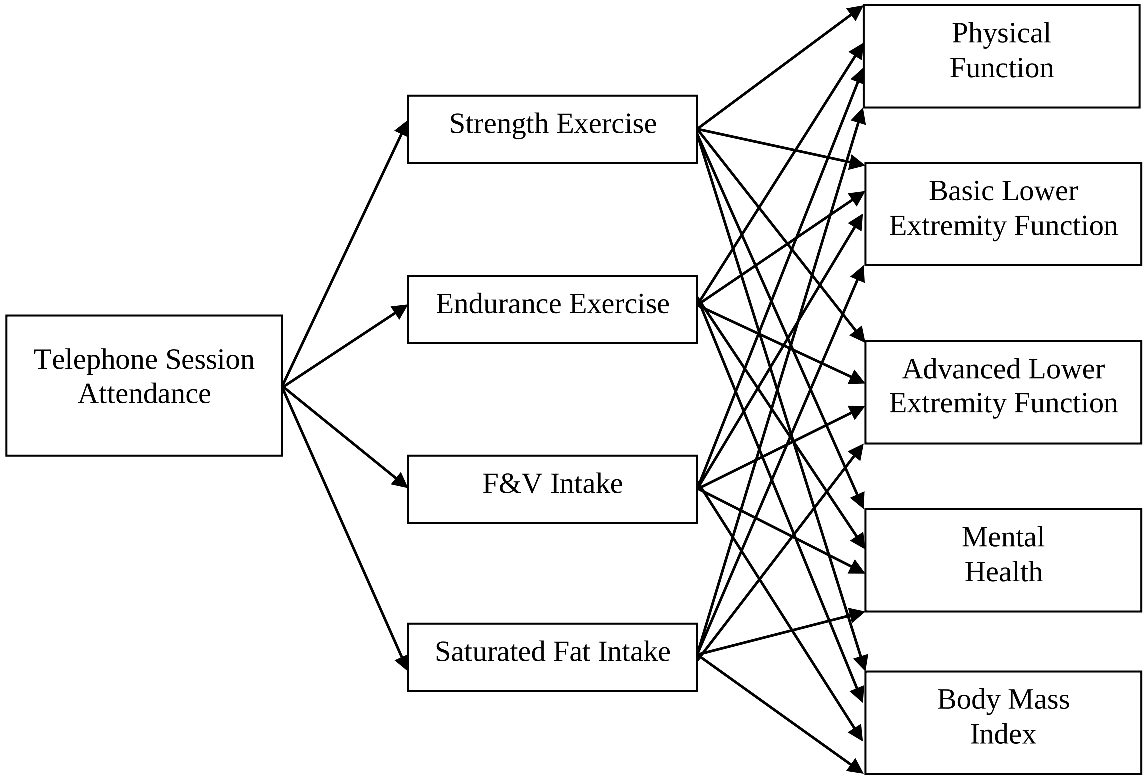

Figure 4. Test of proposed conceptual model. Gender, age, education, and number of comorbidities were included in each of the pathways as covariates. All mediators (i.e., strength and endurance exercise, F&V intake, and saturated fat intake) and outcomes were allowed to covary. χ^2 (5, N = 641) = 5.49, p = 0.36, RMSEA = 0.01.

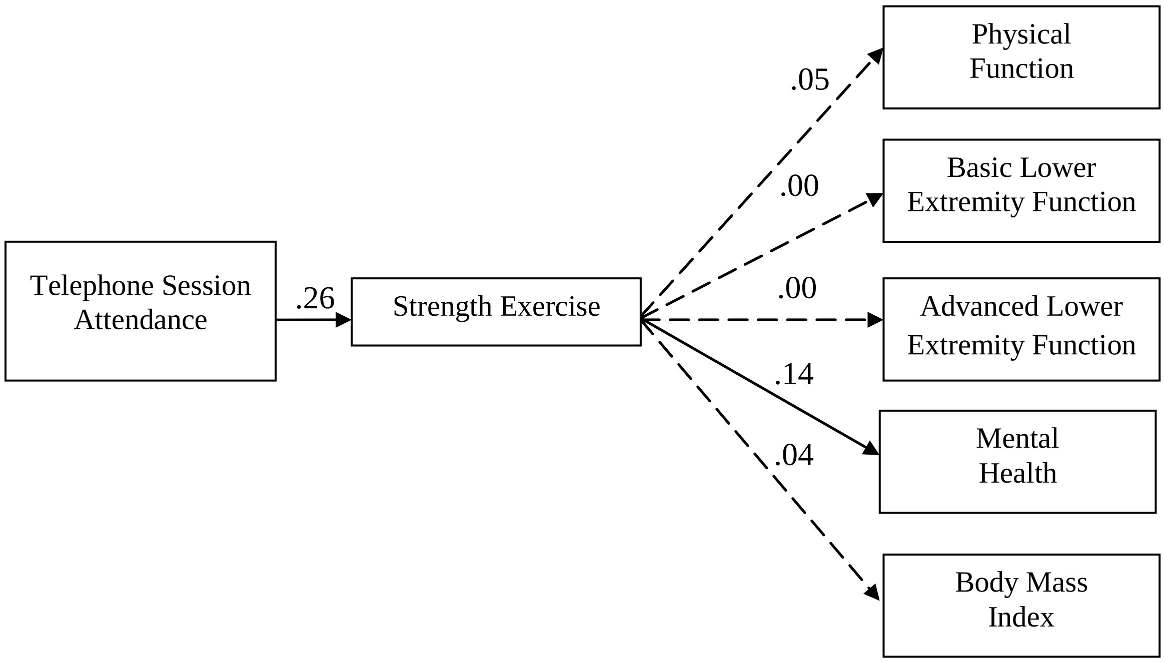

Figure 5. Hypothesis 1. Simplified version of actual model (see Figure 4 for full model). Standardized regression coefficients are presented. Paths represented with solid lines are significant with $p < 0.05$, and dashed lines are non-significant. χ^2 (5, N = 641) = 5.49, p = 0.36, RMSEA = 0.01.

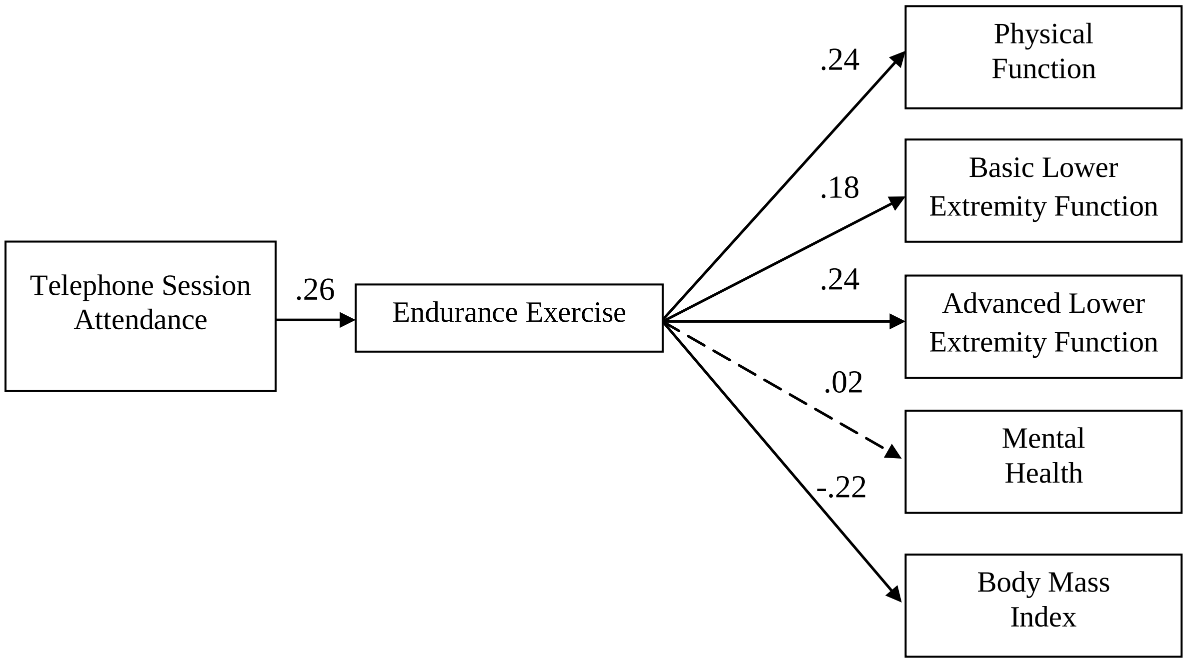

Figure 6. Hypothesis 2. Simplified version of actual model (see Figure 4 for full model). Standardized regression coefficients are presented. Paths represented with solid lines are significant at $p < 0.05$, and dashed lines are non-significant. χ^2 (5, N = 641) = 5.49, p = 0.36, RMSEA = 0.01.

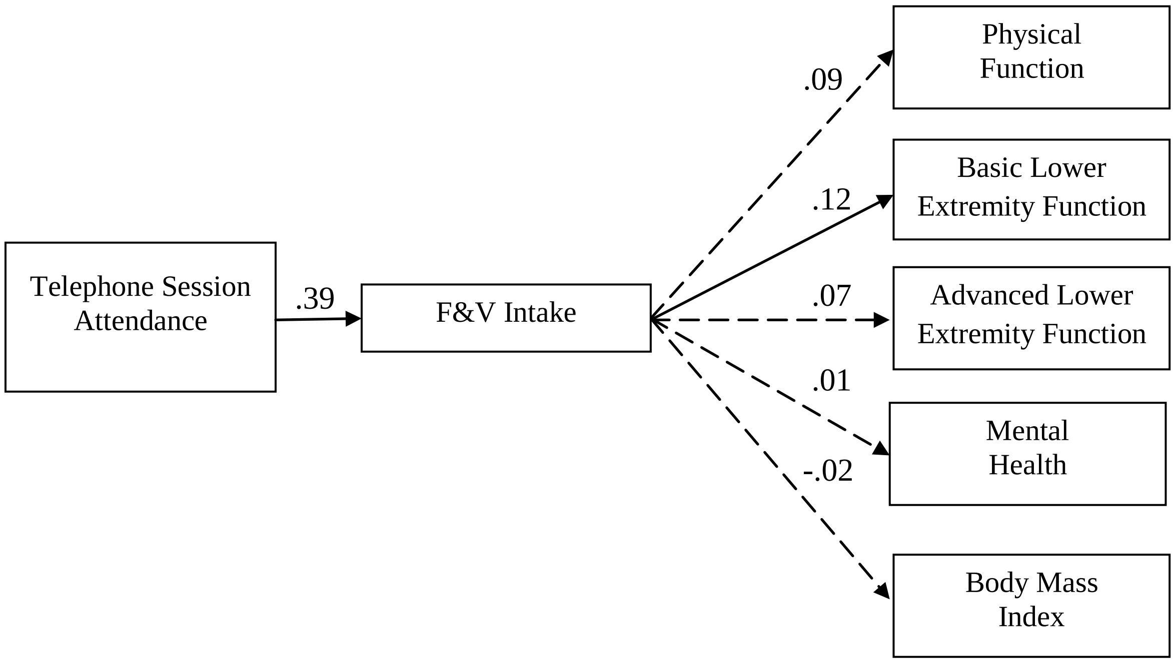

Figure 7. Hypothesis 3. Simplified version of actual model (see Figure 4 for full model). Standardized regression coefficients are presented. Paths represented with solid lines are significant at $p < 0.05$, and dashed lines are non-significant. χ^2 (5, N = 641) = 5.49, p = 0.36, RMSEA = 0.01.

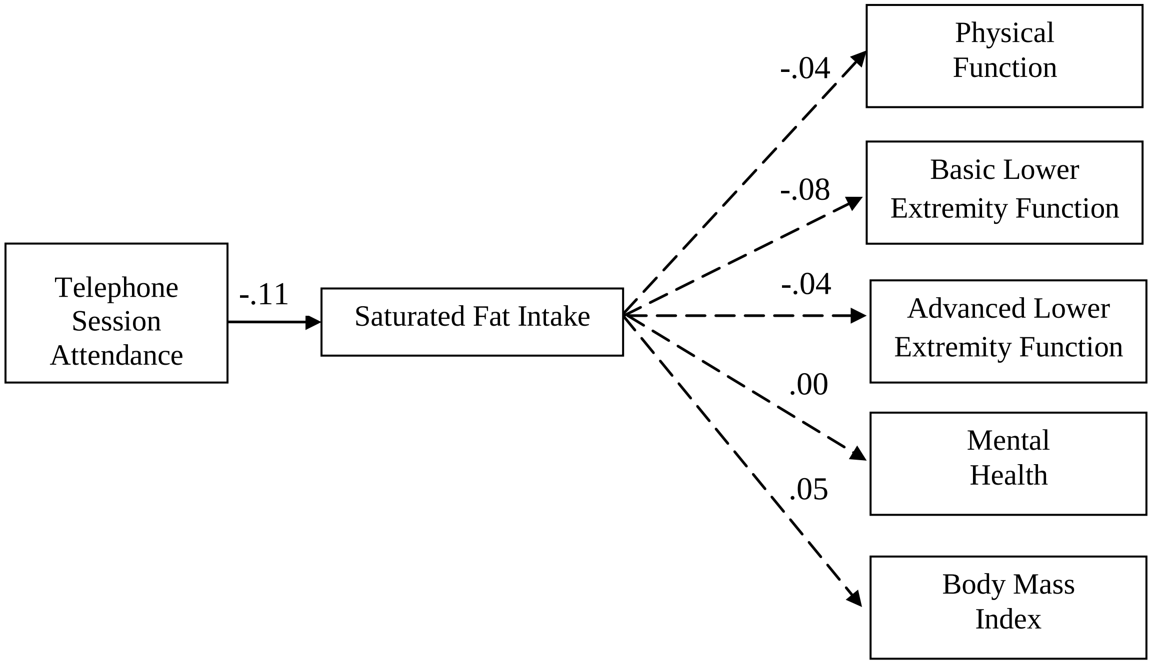

Figure 8. Hypothesis 4. Simplified version of actual model (see Figure 4 for full model). Standardized regression coefficients are presented. Paths represented with solid lines are significant at p < 0.05, and dashed lines are non-significant. χ^2 (5, N = 641) = 5.49, p = 0.36, RMSEA = 0.01.

APPENDIX

APPENDIX: SYNTAX

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OBSERVED VARIABLES
MALE AGE ANYCOLL OARSSUM BMI LLF_BLE LLF_ALE PF MCS TELE_ATT
STR_TOTA END_TOTA FV_TOTAL SATFAT_T
RAW DATA FROM FILE 'C:\Users\jgwinger\Desktop\Lisrel 2.23.13.PSF'
RELATIONSHIPS
TELE_ATT = MALE AGE ANYCOLL OARSSUM
STR_TOTA = TELE_ATT MALE AGE ANYCOLL OARSSUM
END_TOTA = TELE_ATT MALE AGE ANYCOLL OARSSUM
FV_TOTAL = TELE_ATT MALE AGE ANYCOLL OARSSUM
SATFAT_T = TELE_ATT MALE AGE ANYCOLL OARSSUM
PF = STR_TOTA END_TOTA FV_TOTAL SATFAT_T MALE AGE ANYCOLL
OARSSUM
LLF_BLE = STR_TOTA END_TOTA FV_TOTAL SATFAT_T MALE AGE
ANYCOLL OARSSUM
LLF_ALE = STR_TOTA END_TOTA FV_TOTAL SATFAT_T MALE AGE
ANYCOLL OARSSUM
BMI = STR_TOTA END_TOTA FV_TOTAL SATFAT_T MALE AGE ANYCOLL
OARSSUM
MCS = STR_TOTA END_TOTA FV_TOTAL SATFAT_T MALE AGE ANYCOLL
OARSSUM
! freeing covariances between errors of corresponding items
SET THE COVARIANCE OF BMI - MCS FREE
SET THE COVARIANCE OF STR_TOTA AND END_TOTA FREE
SET THE COVARIANCE OF FV_TOTAL AND SATFAT_T FREE
SET THE COVARIANCE OF STR_TOTA AND FV_TOTAL FREE
SET THE COVARIANCE OF STR_TOTA AND SATFAT_T FREE
SET THE COVARIANCE OF END_TOTA AND FV_TOTAL FREE
SET THE COVARIANCE OF END_TOTA AND SATFAT_TOTA FREE
LISREL OUTPUT SS SC EF
PATH DIAGRAM
END OF PROBLEM
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